APPLICATION FOR UNITED STATES LETTERS PATENT

FOR

DISPLAY SCREEN

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DISPLAY SCREEN

RELATED APPLICATIONS

This patent application is a continuation-in-part of US Patent Application Serial No. 09/318,501, filed on May 25, 1999, titled, "Display Screen," Raj at el., (attorney docket 042390. P7131) and of US Patent Application Serial No. 09/318,683, filed on May 25, 1999, titled, "Anti-Reflection Layer in Spatial Light Modulators," by Booth et al., (attorney docket 042390. P7128), these applications being concurrently filed, and assigned to the assignee of the present invention.

This patent application is also related to concurrently filed US Patent Application Serial No. _________, titled, "Tiled Display Screen," by Booth et al., (attorney docket 042390. P9140), assigned to the assignee of the present invention, and herein incorporated by reference.

BACKGROUND

The present disclosure is related to displays, such as display screens.

Display contrast is a factor in the visual quality of a display system. Techniques for improving the contrast of such systems continue to be desirable.

BRIEF DESCRIPTION OF THE DRAWINGS

The subject matter regarded as the invention is particularly pointed out and distinctly claimed in the concluding portion of the specification. The invention, however, both as to organization and method of operation, together with objects, features, and advantages thereof, may best be understood by reference to the following detailed description when read with the accompanying drawings in which:

FIG. 1 is a schematic diagram illustrating an embodiment of a display screen;

FIG. 2 is a schematic diagram illustrating an embodiment of a display screen in accordance with the present invention;

FIG. 3 is a schematic diagram illustrating another embodiment of a display screen in accordance with the present invention; and

FIG. 4 is a schematic diagram illustrating yet another embodiment of a display screen in accordance with the present invention.

DETAILED DESCRIPTION

In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be understood by those skilled in the art that the present invention may be practiced without these specific details. In

other instances, well-known methods, procedures, components and circuits have not been described in detail so as not to obscure the present invention.

As previously discussed, display contrast is a factor in the visual quality of a display system. While some displays or display screens have good contrast in conditions of no or nearly no ambient illumination, such displays or display screens have reduced contrast where ambient illumination is present. This is sometimes due, at least in part, to reflectance of this ambient illumination. Likewise, even in conditions of no or nearly no ambient illumination, display contrast might be improved if light scattering internal to the screen is reduced and, perhaps, even eliminated. Some embodiments in accordance with the invention, such as those described hereinafter, may provide such improved contrast.

FIG. 1 is a schematic diagram illustrating an embodiment 100 of a display screen. FIG. 1 illustrates a cross-sectional view from above. As illustrated in FIG. 1, this embodiment includes a back plane layer 110, a layer 120 that includes emissive pixels, such as 125, a layer 130 that includes holographic film patches, such as 135, and a substrate or cover plate 140. Typically, as will be appreciated by those of ordinary skill in the art, these layers may be comprised of the following materials. Emissive pixel materials, such as layer 120, may comprise inorganic or organic electro-luminescent materials, such as organic light emitting polymers. Holographic film patches may comprise photopolymer or dichroics; back plane layer 110 may comprise ceramic; and substrate of plate 140 may comprise any commonly used optical quality glass; however, other materials may also be employed.

As FIG. 1 illustrates, a holographic film, such as patches 135, 136, and 137, applied to the inside of cover plate 140 absorbs light from the ambient environment incident on the cover

plate, such as light ray 150. In this context, the term holographic film, patch, layer or the like, refers to a film, patch, or layer, for example, made of or including material or materials having the capability to affect or control the transmission or reflection of incident light of specific wavelengths, at least in part, through principles of diffraction. In addition, this film or these patches may absorb light emitted from emissive pixels, such as from 125 or 126, as, for example, where emitted light is back scattered or reflected backwards from the cover plate material or from the interface between the cover plate and the ambient environment, in this example, air. Light ray 160 illustrates this in FIG. 1. In this context, the term holographic film, patch, layer or the like, refers to a film, patch, or layer, for example, made of or including material or materials having the capability to affect or control the transmission or reflection of incident light of specific wavelengths, at least in part, through principles of diffraction. Additional information about this technology may be obtained, for example, from "Holographic Diffusers for LCD Backlights and Projection Screens," by J. M. Tedesco et al., appearing in Society of Information Display (SID) 93 Digest, paper 5.3, pp. 29-32 (1993); "A Novel High-Resolution Ambient-Light-Rejection Rear Projection Screen," by D. W. Vance, appearing in SID 94 Digest, paper 34.2, pp. 741-744 (1994); and "Rear Projection Screen for Light Valve Projection Systems," by J. F. Goldenberg et al., appearing in Proc. of Society of Photo-Optical Engineers (SPIE), Vol. 3013, pp. 49-58 (1997).

However, as previously indicated, additional improvements in contrast remain desirable. For example, in FIG. 1, some ambient light and internal light that is scattered may not be absorbed. This light may reduce display contrast and, therefore, degrade visual quality.

FIG. 2 is a schematic diagram of an embodiment 200 of a screen display in accordance with the invention. FIG. 2 is also a cross-sectional diagram shown from above. Of course,

FIG. 2 illustrates only one of many possible embodiments within the scope of the present invention. Therefore, the invention is not restricted to this particular embodiment, and this particular embodiment, 200, is provided merely as an illustration.

Embodiment 200 in FIG. 2 illustrates a display screen, such as may be employed in a flat panel display for a display system. Although the invention is not limited in scope in this respect, such systems may employ liquid crystal technology. This particular embodiment includes a back plane layer 210, a layer 220 including emissive pixels, such as 225, a layer 230 that includes holographic film patches, such as 235, and a cover plate layer 240. Here, the layers combine to form a display screen having a structure so that at least some light is emitted from the emissive pixel layer into the ambient environment. This is desirable so that an image on the display screen may be viewed. In addition, the holographic film layer includes patches of holographic film having a front and back side, where the front side of the holographic film patches faces the cover plate layer and adjacent structures are formed therein, such as 255 and 265 or 256 and 266, to trap at least some incident light, as described in more detail below.

As illustrated in FIG. 2, the layer that includes the holographic film 230 is patterned as a grid in this embodiment. This provides openings for emitted light to be transmitted to a viewer capable of perceiving an image on the display screen, for example. However, the holographic patches or plates comprise a material capable of absorbing at least a portion of light incident upon the material. Furthermore, as illustrated in FIG. 2 by light rays 250 and 260, the adjacent structures, such as 256 and 266, are formed to trap light incident upon the material that is not initially absorbed by the material. In this particular embodiment, structures, such as 255 and 265, have a moth-eye-like shape, although the invention is not limited in scope in this respect.

A variety of shapes may be employed that are capable of trapping light, as desired. For example, alternatively, a pyramid-like shape or a pillar-like shape may be employed. As illustrated, in this embodiment, the structures are shaped so that incident light not initially absorbed by the holographic film is reflected to again impinge upon the material. Furthermore, here the structures are shaped so that even if light is not absorbed after multiple reflections, it will continue to impinge upon the material. In this context, this is referred to as "trapping" the light, such as for light that is either not reflected out of the screen display or that is reflected within the screen display, but away from the holographic film or patch, in this particular embodiment.

The invention is not limited in scope to a particular holographic material, however, examples of such material include: Photopolymers, such as available from E.I. du Pont de Nemours and Company, Wilmington, Delaware (hereinafter, "DuPont"); and/or High Energy Beam Sensitive (HEBS) glass, such as available from Canyon Materials, Inc. The amount of absorption and reflection that occurs for incident light depends at least in part upon the particular material employed; however, material, such as photopolymers, for example, may be employed in some embodiments, for example, where approximately in the range of from 2 to 10 percent of the incident light is reflected. Therefore, due at least in part to the shape of the adjacent structures, unabsorbed light is reflected so that the next time it impinges upon the material it may be approximately 90 to 98 percent absorbed and approximately 2 to 10 percent reflected, for this embodiment, although, the invention is not limited in scope to these percentages and they may vary depending upon a variety of factors. However, again, this may be repeated multiple times so that a relatively small amount of bulk reflectance takes place.

Holographic films having the desired structure may be fabricated on planarized surfaces using a technique called interference lithography, although the invention is not limited in scope to employing only this technique. For example, Holographic Lithography Systems, based in Bedford, MA, employs such fabrication techniques. In this context, the term interference lithography refers to a holographic technique, typically maskless, in which patterning of material occurs via electromagnetic interference. Using such an approach, feature sizes as small as 90 nanometers, for example, may be patterned over a relatively wide area. Likewise, this technique may be employed to fabricate structures such as 255 and 265 or 256 and 266, shown in FIG. 2 and as previously described. In addition to producing structures having relatively low reflectance over relatively large wavelength bands and relatively large angular acceptance ranges, this approach allows for fabricating the structures for wavelength selectivity or "tuning." For example, this may be employed in some embodiments to provide color balancing, if desired. Again, although the invention is not limited in scope in this respect, one example of a commercially available holographic film suitable for such fabrication is available from DuPont.

In an alternative approach, HEBS gray level masks may enable mass production of three-dimensional (3D) microstructures that may also be employed. For example, it may be possible to fabricate a gray-level or gray-scale mask using a standard e-beam tool. HEBS-glass turns dark upon exposure to an electron beam. Furthermore, controlling the electron dosage may control the level of darkness. Therefore, HEBS-glass may be capable of resolution to molecular dimensions. There are a number of potential advantages, such as reduction in alignment errors, reduction in the use of chemicals, and an economical mask fabrication technique. Canyon Materials, Inc., San Diego, CA, for example, makes custom HEBS-glass gray level masks . These gray-level masks enable mass fabrication of 3-D

microstructures and may employed in several fields of micro technology, including fabrication of embodiments of holographic films and/or patches in accordance with the present invention. Again, the forgoing are just two examples of techniques that may be employed to fabricate the desired structures and the invention is not in scope to a particular technique.

FIG. 3 is a schematic diagram illustrating another embodiment in accordance with the invention, again, illustrated in cross-section from above. Here, embodiment 300 comprises a screen display that includes a back plane 310, emissive pixels, such as 325, holographic film patches, such as 335 and 345, and a cover plate, 340, combined in layers to form a display screen having a structure so that at least some emitted light is transmitted into the ambient environment and so that at least some light propagating within a layer that includes emissive pixels is absorbed, although, again, the invention is not limited to this particular embodiment.

This embodiment is similar to the previous embodiment in that both light reflected within the display screen and ambient light transmitted into the display screen is absorbed by a holographic film. This is illustrated, for example, by light rays 350 and 360. Whereas in the previous embodiment light is absorbed by adjacent structures, here, the holographic patches are positioned in different layers so that light that is scattered or reflected to within the layer that includes the emissive pixels may be absorbed. This is illustrated in FIG. 3 by light ray 360 and patch 326 and by light ray 350 and patch 327.

FIG. 4 is a schematic diagram illustrating yet another embodiment in accordance with the invention, again, illustrated in cross-section from above. Here, embodiment 400 comprises a screen display that includes a back plane 410, emissive pixels, such as 425, holographic film patches, such as 435 and 445, and a cover plate, 440, combined in layers to form a display

screen having a structure so that at least some emitted light is transmitted into the ambient environment and so that at least some light propagating within a layer that includes emissive pixels is absorbed, although, again, the invention is not limited to this particular embodiment.

This embodiment is similar to the previous embodiment; however, whereas in the previous embodiment light is absorbed by holographic patches positioned in different layers so that light that is scattered or reflected to within the layer that includes the emissive pixels may be absorbed by a holographic film, in FIG. 4, some holographic film or films are being employed to reflect a major portion of the incident light. This is illustrated in FIG. 4 by light ray 460 and patch 445, for example. Therefore, the invention is not limited in scope to employing holographic materials primarily to absorb incident light. In some embodiments, depending on the circumstances, holographic materials may also be employed in some instances, at least, primarily to reflect incident light.

An embodiment of a method of trapping at least a portion of light incident upon the front side of a holographic film, such as may be performed by embodiment 200 illustrated in FIG. 2, for example, includes the following. At least a portion of the light, in some embodiments, as previously described, a major portion of the light incident on the front side of holographic film, such as 230, illustrated in FIG. 2, for example, may be absorbed. Likewise, the remaining incident light that is not absorbed, at least initially, may be reflected in a manner so as to be incident upon the front side of the holographic film again. For the light that is again incident upon the front side of the holographic film, at least a portion, in some embodiments, as previously described, a major portion, of this again incident light may be absorbed into the front side of the holographic film, whereas the remaining, not absorbed, again incident light may be reflected in a manner so as to be incident upon the front side of the holographic film

yet again. This may be repeated multiple times. At least some of the light initially incident upon the front side of the holographic film may comprise light reflected backwards, such as reflected or scattered from inside face 201 of cover plate 240 in FIG. 2, for example.

In another embodiment, a method of trapping at least a portion of light scattered by an inside face, such as 201, of a cover plate, such as 240, of a display, such as 200, may include the following. At least some of the scattered light incident on the front side of a holographic film, such as patch 235, may be absorbed, in some embodiments, a major portion. The remaining scattered light incident on the front side of the holographic film may be reflected in a manner so as to be again incident upon the front side of the holographic film after reflection. Furthermore, again, as described for the previous embodiment, this may be repeated multiple times. For example, in one embodiment, as illustrated in FIG. 2, light may be reflected between two adjacent structures, such as 255 and 265 or 256 and 266, in the front side of the holographic film or patch

It will, of course, be understood that, although particular embodiments have just been described, the invention is not limited in scope to a particular embodiment or implementation. Likewise, although the invention is not limited in scope in this respect, one embodiment may comprise an article, such as a display screen. Such a display screen may be employed, for example, as part of a system, such as a host computer, a computing system, a platform, or an imaging system.

While certain features of the invention have been illustrated and described herein, many modifications, substitutions, changes and equivalents will now occur to those skilled in

the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.